Navigating in Process Model Collections: A new Approach Inspired by Google Earth*

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Abstract. In complex business environments, business processes (e.g., engineering processes in the automobile industry) may comprise hundreds up to thousands of process steps. Though typically captured in a process model (or a collection of process models), these processes are presented to process participants in a rather static manner, e.g., as simple drawings. However, to effectively support process enactment and to link processes with relevant information, enterprises crave for new ways of visualizing processes and for interacting with them. In particular, process models must be provided in an interactive, more dynamic manner, i.e., they must be both ”experiencable” and user-adequate from the perspective of the user. In this paper, we introduce a new process navigation concept for querying process model collections. Specifically, we pick up an existing navigation concept for complex information spaces, namely Google Earth, and apply it to business processes. Thereby, we distinguish between geographical and semantic zoom functions, introduce different process views and filter mechanisms, and discuss options to manually configure needed process visualizations.

Key words: process navigation, visualization and interaction

1 Motivation

In complex environments business processes (e.g., engineering processes for electric/electronic components in a car) may comprise hundreds up to thousands of process steps, each of them being associated with process relevant information such as engineering documents, contact information, or tool instructions. In existing process repositories models are typically visualized in a static and thus not very helpful manner [1, 2, 3]. In this context van Wijk confirms that visualizing large data sets often leads to large and static “images” with much detail [4]. Static visualization, in turn, results in a significant information overload, rather

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disturbing than supporting the user. As different process participants have different perspectives on a business process and related process information, a more flexible visualization of process models and navigation within business process collections become necessary. For example, a business manager is mainly interested in an overview of a process in order to evaluate its process progress, whereas a knowledge-worker needs more detailed information about the process step he is currently involved in. In a case study [5] we showed that no comprehensive approach fulfilling this requirement is currently available. Only specific aspects are addressed in literature so far.

PROVIADO [6], for example, tackles the challenge of flexible process visualization but focuses on the technical viewpoint, i.e., the user viewpoint has not been considered. Interesting concepts have been introduced in the area of user interface design, e.g., zoomable user interfaces (ZUIs) [7]. Smirnov et al. [8] state that *abstraction* has proven to be an effective means to present readable, high-level views of business process models.

Picking up the demand to adopt the user perspective when navigating in process models or process model collections [9, 10], we introduce an advanced *navigation concept* allowing users to dynamically adapt the visualization of processes depending on their personal needs. Figure 1 illustrates our understanding of process navigation. The process user starts with a default visualization of a business process (Visualization 1), e.g., depicting the entire process with detailed process information. The user may then change the visualization by interacting with the process(es). *Process interaction* is defined as an activity that transforms one process visualization into another based on user-triggered operations. For example, a user may adjust the zoom level, and the process visualization then changes accordingly. Process navigation comprises a sequence of process interactions and allows the process participant to navigate from a default visualization (Visualization 1) to a more specific one (Visualization 4).

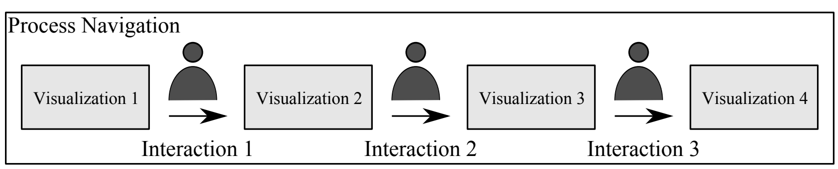


Fig. 1. Process Navigation: A sequence of process interactions.

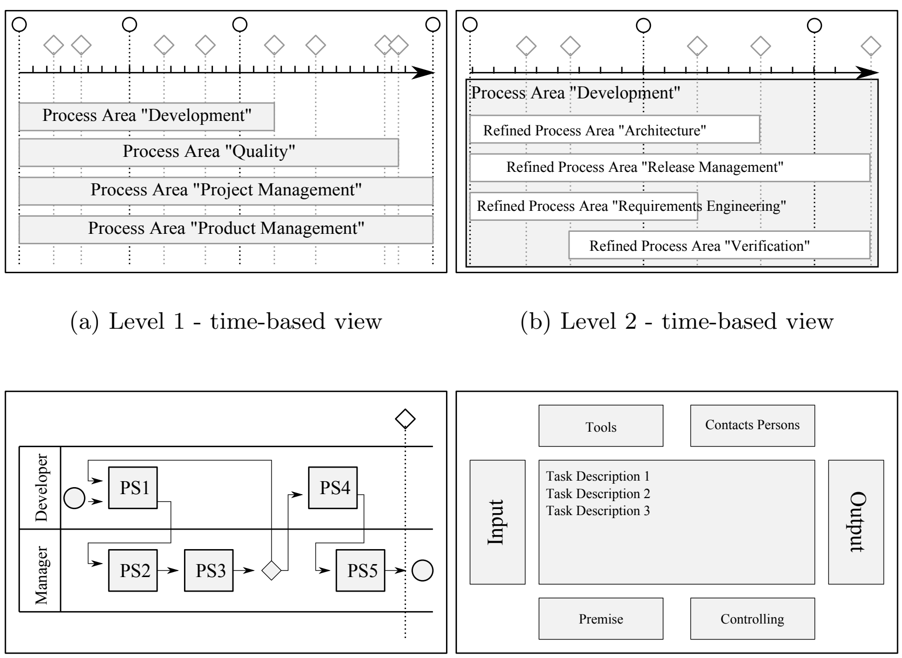
This work was done in the context of the niPRO project, which applies semantic technology to integrate information associated with business processes in personalized *process information portals*. As examples of structured process information consider graphical business process models or data from enterprise information systems such as ERP or CRM systems. Examples of unstructured process information include all kinds of office documents or e-mails, including mainly plain text. The overall goal is to provide knowledge-workers and decision-makers with the needed process information depending on their preferences and current work context.

This paper is organized as follows: Section 2 presents a navigation example of a complex electric/electronic development process from the automotive domain and summarizes requirements we previously identified on process navigation. Our navigation concept is introduced in Section 3. Section 4 discusses related work and Section 5 concludes with a summary and outlook.

2 Process Navigation: Example and Requirements

2.1 Practical Example

We first present a real-world case from the automotive domain to illustrate the need for an intuitive process navigation concept. In this case, all relevant processes are documented in forms of process diagrams captured in PDF documents. Furthermore, they are categorized into process areas. Each process area is depicted as image map to users. Altogether, the entire "process world" (or process model collection) comprises various models with different levels of information (cf. Fig. 2).



(a) Level 1 - time-based view

(b) Level 2 - time-based view

(c) Level 3 - logic-based view

(d) Level 4 - turtle-view

Fig. 2. Real-world example from the automotive industry.

Level 1 (cf. Fig. 2(a)) shows the entire process world, i.e., process areas. As displaying single business processes would be too complex at this point, only process areas are depicted. The respective view is time-based, i.e., the length of the rectangles corresponds to the duration of process areas. Level 1 provides the start point for the user. Based on it, he or she may select the process area including the needed process step or process information. By choosing the process area "Development", for example, the user gets a more detailed, but still time-based view of this process area on Level 2 (cf.Fig. 2(b)). The lots of single processes can be displayed at Level 3 (cf. Fig. 2(c)). In our example, the process "Requirements Engineering" is depicted in terms of a process diagram, in which single process steps (PS1. . . PS5) are connected to indicate causal relations. Further, roles are introduced on this level and are displayed as swim lanes. As opposed to Levels 1 and 2, the view on Level 3 is logic-based, e.g., it allows modelling feedback loops (e.g., to jump back from PS3 to PS1) if a certain condition is not met. Each process step is further refined on Level 4. It provides a "turtle-view" and neither has time nor logic restrictions. A turtle only contains information of a single process step in terms of task descriptions and additional information, e.g., on tools or contact persons. The turtle-view is the most detailed visualization and thus represents an important destination when searching for process information.

This practical example exhibits two weaknesses. First, the presentation of the different levels of information is inconsistent. While Levels 1 and 2 provide static image maps, Levels 3 and 4 are PDF files. Navigating from Level 3 to Level 4 corresponds to a simple scrolling through the PDF file. Second there are missing relations between different processes.

2.2 Requirements

To elaborate the requirements for process navigation, we performed two case studies, an online survey, and a literature study [5, 11]. Table 1 summarizes the major requirements, we identified in these empirical studies. Requirements 1, 4 and 6 are picked up in the following as they directly concern process navigation.

3 Process Navigation Approach

As already mentioned in Section 1, we consider process navigation as the procedure to navigate in process model collections and process model repositories. Process navigation is triggered by a user and comprises a sequence of user interactions.

In this section we present our process navigation approach inspired by Google Earth. Generally, process models and process model collections constitute complex information spaces. Google Earth, in turn, provides a navigation concept for one of the most complex existing information spaces, namely the global geographical information space. Of course, there exist significant differences between process models and global geographical information. Hence, we consider

Nr.	Name	CS1	CS2	OS	Lit
#1	A graphical visualization of the entire business process is needed	x	x	x	x
#2	Enterprise-wide processes being easily accessible in every department are required	x	x	x	
#3	Continuously provide information on the process progress	x			x
#4	An adequate visualization of process information is required	x	x	x	
#5	Process information must be explicitly linkable to single process steps	x			
#6	Information on contact persons should be adequately visualized		x		x
#7	Process steps must be linked with associated roles		x		
#8	Process information must be provided on the user's role	x	x	x	x

CS1: Case Study 1; CS2: Case Study 2; OS: Online Survey; Lit: Literature

Table 1. Derived requirements from our empirical studies.

the Google Earth navigation approach just as the starting point for our ideas and we are working on necessary extensions and adaptations.

3.1 Google Earth

Google Earth[2] is a virtual globe, map and geographical information system. It displays satellite images of varying resolution of the earth's surface, allowing users to browse items like cities and houses looking perpendicularly down or at an oblique angle [12]. Google Earth allows users to search for addresses of certain countries, to enter coordinates, or to simply use the mouse to browse to a particular location. The user is able to zoom, to pan, and to rotate the maps. The level of detail of the displayed information is automatically adjusted to the geographic zoom level. Further, users can switch between different views of the map, e.g., map-view, satellite-view and terrain-view.

3.2 Adopting Google Earth for Process Navigation

We now take the Google Earth navigation concept and adopt it to our scenario from Section 2. Table 2 shows the four different levels of the previously described process world from Section 2. Our goal is to map these levels to Google Earth.

Zoom-Level	Business Processes	Google Earth
Level 1	Process World	Globe
Level 2	Process Area	Continent
Level 3	Process	Country
Level 4	Process Step	City

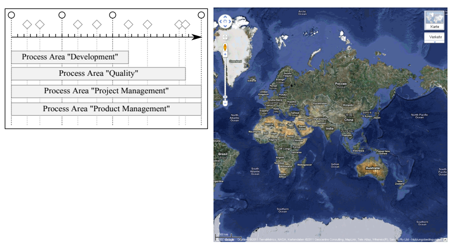
Table 2. Mapping of terms.

As can be seen in Figure 3(a), Level 1 of our scenario corresponds to the entire globe in Google Earth. Process areas, in turn, can be considered as continents

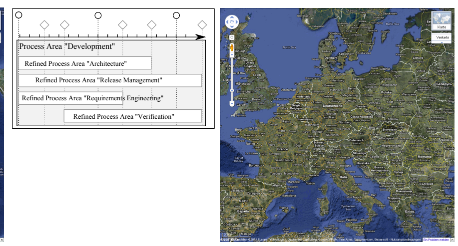
[2] earth.google.com

(cf. Fig. 3(b)). Note, that both the globe and the continents are depicted from the same view (i.e., the satellite view). On Level 3 (cf. Fig. 3(c)), Google Earth switches to another view, namely a map-oriented view. On this level Google Earth shows single countries. Picking up again our scenario, a single country corresponds to a single process. Finally, single process steps (Level 4) correspond to single cities in Figure 3(d). The view has changed again, now to a terrain view in Google Earth.

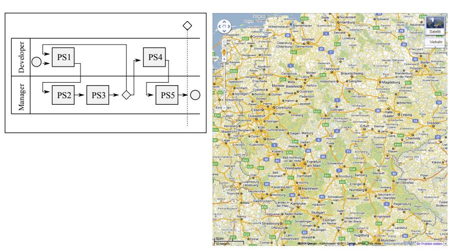
Obviously, Google Earth can be applied to our real-world scenario and to its different levels of information detail and views.



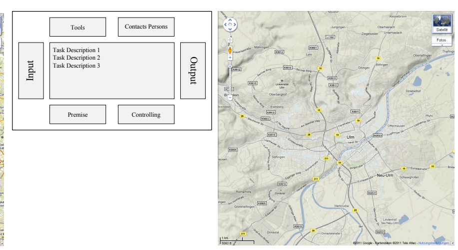
(a) Level 1 - satellite view



(b) Level 2 - satellite view



(c) Level 3 - map view

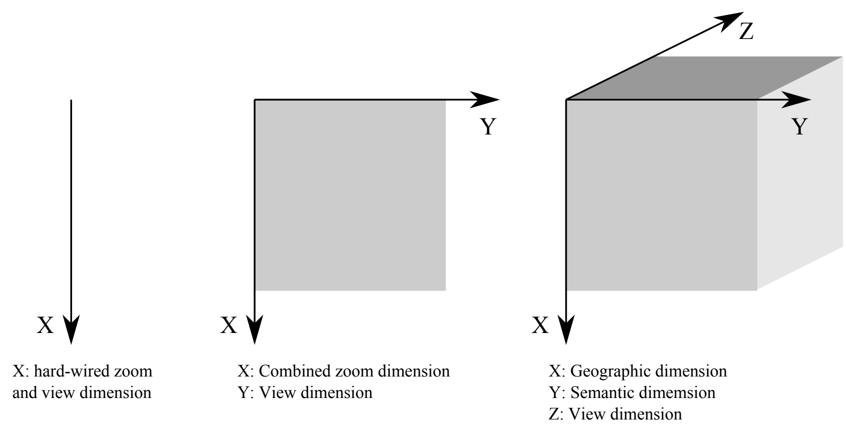


(d) Level 4 - terrain view

Fig. 3. Mapping navigation concept to Google Earth.

However, in the presented example, process navigation still remains restricted. The process user, for example, cannot manipulate the hard-wired zoom levels and views. Level 3, for instance, is always depicted as a logic-based view. Indeed, the user can adjust the level of information detail (i.e., one dimension, the dimension X in Fig. 4(a)), but the view is then automatically selected.

The Google Earth concept, in turn, supports two navigation dimensions to overcome these restrictions. The first dimension is the *level of zoom* (X) (i.e., the information detail). The second dimension subsumes different *views* (Y). We can depict these two dimensions as a matrix (cf. Fig.4(b)). As we can identify four different information levels and three different views in our real-world scenario (cf. Section 2), a corresponding Google Earth navigation can be depicted as 4×3 matrix. Thus, twelve different visualizations are possible compared to the four visualizations of our original example (cf. Fig 2).



(a) Real-world example (b) Google Earth (c) Process Navigation Concept

Fig. 4. The enhancement of navigation dimensions.

Even the Google Earth navigation concept (with its two dimensions) is not able to completely meet all the requirements described in Section 2. For example, consider a manager who wants to see detailed information about the progress of a specific process, but who must also have an overview over all other processes at the same time. Picking up the Google Earth metaphor, this scenario can be described be as follows: The user wants to see selected cities of countries, but also wants to see the whole globe at the same time. The Google Earth navigation concept cannot solve this problem. The user can either zoom in (i.e., he may see single cities, but then looses the overview on the globe at the same time), or he can zoom out (so that he sees the globe, but single cities are not shown).

We address this issue by picking up techniques from the area of user interface design. Reiterer and Buering [7], for example, investigate respective techniques and distinguish between *geographic* and *semantic* zoom. In the following, we enhance the Google Earth navigation concept by introducing these additional dimensions. In total, this leads to three navigation dimensions: the geographic dimension (X), the semantic dimension (Y), and the view dimension (Z) (cf. Fig4(c)).

3.3 Process Navigation Dimensions

We now describe the three mentioned dimensions in detail.

Geographic Dimension The geographic dimension allows for a visual zooming without changing the level of information detail. Think of a magnifier while reading a newspaper. To set different zooming levels, scales can be used. In the area of user interface design, Wijk et al.[4] already introduced a similar technique.

Semantic Dimension In the semantic dimension, process information is displayed in different levels of detail. On a high semantic level, for example, only the names of process steps are depicted. If the semantic level of the respective process step is more detailed, further details like the duration, responsible roles and contact persons may be shown as well.

View Dimension Different views enable the user to select different types of process information, such as time aspects, documents, contact persons or logical relationships to other information. As opposed to the semantic dimension, the detail level of information remains on a constant level, i.e., only the point of view is changed. In Figure 2, three dimensions have already been introduced. The time-based view (cf. Fig.3(a)) emphasises time aspects and uses a time line. The logic-based view accentuates logic relations between process steps (cf. fig. 3(c)). Finally, the turtle-view represents task descriptions (cf. Fif 3(d)). An additional (i.e., fourth) view is introduced in Figure 5. Here the focus is on the information flow, i.e., on documents or responsible contact persons.

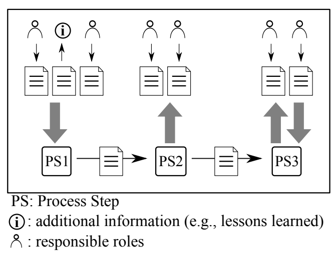


Fig. 5. A view emphasising the information flow between different process steps.

With these three navigation dimensions, the user is able to navigate in and across complex business processes.

Generally, a completely unrestricted navigation within and across process models is not always useful as some visualizations do not make sense. As example consider the following scenario in which the geographic zoom is on an abstract level, i.e., the whole process world (the entire globe) is visible. At the same time the semantic zoom corresponds to a very detailed level, i.e., process information is displayed to each process step (information to all cities around the world are shown). As result we would obtain the visualization of the process world with a multitude of detailed process information, overlapping with each other, due to limited screen size.

Figure 6 shows a schematic navigation element supporting these three dimensions. For the geographic dimension (G), a slider control (well known from Google Earth) can be used. To adjust the semantic dimension (S), we use check boxes. A check box gives the user the possibility to select or deselect single levels of information. Finally, as only one view (V) can be depicted at the same time, we use radio buttons to select the respective view.

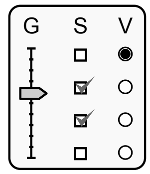


Fig. 6. Three zooming options. (**G**eographic, **S**emantic, **V**iews)

3.4 Filter Mechanism

As aforementioned, the freedom to arbitrarily navigate within three navigation dimensions is not always meaningful for the user. Hence, we introduce additional filter mechanisms enabling more sophisticated navigation possibilities. To illustrate our filter mechanism, we pick up our scenario again. Showing process steps (semantic dimension) of the whole process world (geographic dimension) does not make sense unless we use appropriate filter attributes to reduce the amount of displayed information. In general, every process information represents an attribute that can be potentially used to generate filters. Respective filters allow reducing the information displayed in the context of a particular process visualization based on certain rules. These rules, in turn, may refer to a number of filter attributes. For example, one possible filter attribute could be the duration of process steps or the responsible role. For example, the following inquiries are possible:

- Show all process steps associated with the role "Quality Manager".
- Show all process areas with the roles "Quality Manager" and "Software Developer" being involved.

In the following we present an example to illustrate how our process navigation concept works in conjunction with the introduced filter mechanism. Table 3 shows the different views and levels we use in this example.

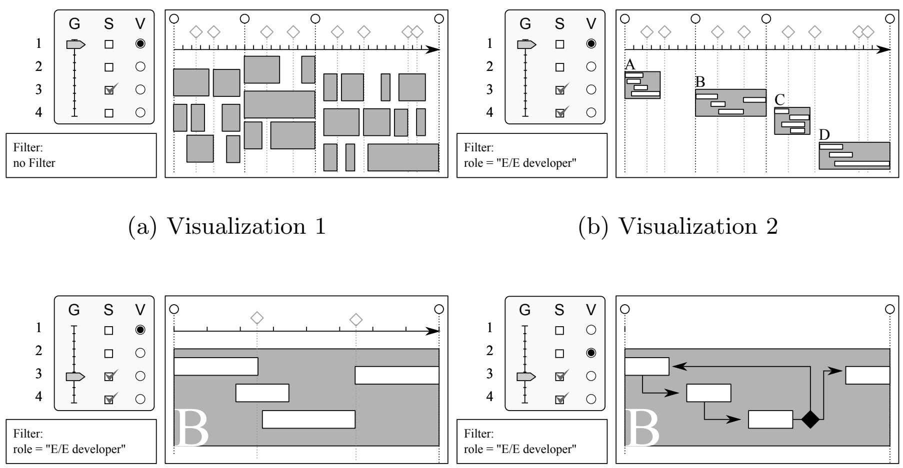
Level	Semantic Zoom	View
1	Process World	time-based
2	Process Area	logic-based
3	Process	turtle-view
4	Process Step	informationflow

Table 3. Caption for our example.

Navigation starts with a view of the entire process world (cf. Fig. 7(a)), similar to the PDF document. However, it includes additional information. The geographic level corresponds to Level 1, i.e., the entire process from its start until its end is shown (from a time-based view). Semantically, only information on the level of processes is depicted (semantic zoom level 3).

A user having role "E/E (electric/electronic) developer" is only interested in processes, he is involved in. For this purpose, he can use our filter mechanism by setting up attribute role to "E/E developer" (cf. Fig. 7(b)). At the same time he may select semantic level 4 to display all process steps in addition to the processes he is involved in (semantic level 3). As the user is interested in a specific process step in process B, he applies the geographical zoom to process B (cf. Fig. 7(c)) in order to get a better overview on it. Note, that all interactions are user-driven.

Finally, assume that the user is less interested in time aspects, but in what he has to do next, when finishing the current process step. Therefore, he switches to the logic-based view as depicted in Figure 7(d). Here, he can identify successors of the current process step he has worked on.



(a) Visualization 1 (b) Visualization 2

(c) Visualization 3 (d) Visualization 4

Fig. 7. Example of navigating in three dimensions including the use of filters.

The example demonstrates that the combination of our navigation concept with the sketched filter mechanisms supports the user in finding needed information in large process model repositories.

4 Related Work

Related work mainly stems from two areas: (1) business process visualization and navigation & (2) zoomable user interfaces.

Vajna [13] introduces a system, which enables the modelling and evaluation of any kind of process or project as well as the dynamic navigation through it. The behaviour of this system is described as "navigation", because it always leaves the control and the decision for the user, as opposed to "process control", where processes are fixed and thus controlled automatically. Bobrik et al. [6] criticise that existing BPM tools lack the flexibility of presenting personalized process views to users. As different users have distinguished perspectives on business processes and related data, in large organizations this flexibility becomes crucial. In response, a view concept is suggested that enables advanced support for process visualization with focus on reducing the complexity of business processes. Schoenhage et al. [14] investigate business visualization in 3D. They pick up a 2D visualization of a business process as a starting point, for which they subsequently provide a 3D visualization. With this approach, data visualization in multiple dimensions (e.g., past, present and simulated data) becomes possible.

In the area of zooming techniques van Wijk and Nuij [4] state that large 2D information spaces such as maps, images or abstract visualizations require views at various levels of detail. They further state that users often switch between these different views and discuss how a smooth migration from one view to another can be realized. For this purpose, they introduce a metric on the effect of simultaneous zooming and panning.

With JAZZ [15] and Pad++ [16], Bederson show how zooming techniques can be used as a foundation for intuitive user interfaces. More general zooming techniques are presented by Reiterer et al. [7]. Zooming facilitates data presentation on limited screen real-estate by allowing the users to alter the scale of the viewpoint such that it shows decreasing fraction of the information space with an increasing magnification. As additional technique, *panning* is introduced, i.e, the moving in constant scale. Such user interface concepts are implemented in *Squidy*, a zoomable design environment for natural user interfaces [17], in *ZEUS*, a zoomable explorative user interface for searching and object presentation [18], and in *ZOIL*, a cross-platform user interface paradigm for personal information management [19]. Dieberger and Frank [20] propose a conceptional user interface metaphor for complex information spaces based on the structure of a city, as people are used to navigate within cities to reach particular destinations.

5 Summary and Outlook

In this paper we suggest a new process navigation approach for large process model collections and process models. Specifically, we pick up an existing navigation concept for complex information spaces, namely Google Earth, and apply it to business processes. We introduce geographic and semantic zoom functions and describe different process views and sophisticated filter mechanisms. The presented process navigation ideas, though not fully implemented yet, allow users to better navigate through complex process model collections. Future work will address the further specification and formalization of the presented ideas and their evaluation in case studies and user experiments.

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